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STUDIES OF CERTAIN APOGONID FISHES FROM THE INDO-PACIFIC, WITH DESCRIPTIONS OF THREE NEW SPECIES

By Ernest A. Lachner

A Faunal study of the Apogonidae of the northern Marshall Islands brought to my attention many taxonomic problems involving certain species of the family distributed elsewhere in the Indo-Pacific region. The present paper, a result of this study, includes: 1, A review of the genus *Archamia;* 2, studies of the *Apogon bandanensis* group; and 3, studies of the genus *Paramia.* Three species are described as new.

I wish to thank Donald S. Erdman, formerly of the United States National Museum, for certain field notes; Dr. Ethelwynn Trewavas, of the British Museum (Natural History), and Prof. L. Bertin, Muséum National d'Histoire Naturelle, Paris, for correspondence concerning type specimens; and Dr. J. L. B. Smith, of the Rhodes University College, Grahamstown, South Africa, for kindly providing data and specimens of *Archamia* from Africa. I am indebted to the staff of the Smithsonian photographic laboratory for the photographs.

METHODS OF COUNTING AND MEASURING

The last ray of both the soft dorsal and the anal fins, divided to the base, is considered as one. All rays of the pectoral fin are counted, including the very small unbranched one at the lower end of the fin base. The count of lateral-line scales includes all scales on the body from the upper edge of the gill opening along the lateral line to the end of the hypural at the base of the caudal fin rays. The scales above the lateral line are counted downward in a posteriorly oblique row

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from the origin of the spiny dorsal fin to the lateral-line-scale row and below the lateral line upward in an anteriorly oblique row from the origin of the anal fin to the lateral line. In these two counts, the lateral-line-scale row is not included. The total number of gill rakers recorded includes all rudiments and developed rakers on the first right arch. In some species it is important to tabulate separately the number of rudiments from the developed rakers. In these cases, the number of rudiments is recorded preceding the number of developed rakers on the upper limb and separated by a comma. On the lower limb the rudiment count follows the developed-raker count. The raker at the angle of the arch is preceded and followed by a plus sign and thus distinguished from those on the limbs (e. g., 2,5+1+16,3 or 7+1+19). All measurements of the length of a fish refer to the standard length.

A REVIEW OF THE GENUS ARCHAMIA

Genus ARCHAMIA Gill

Archamia Gill, 1864, p. 81. (Orthotype, *Apogon bleekeri* Günther, 1859 = *Apogon fucatus* Cantor, 1850, or *Apogon lineolatus* Cuvier and Valenciennes, 1828.)

A useful key to the genera of the apogonid fishes was presented by Schultz (1940, pp. 404–408). The significant characters referred to by Schultz for *Archamia*, the number of anal fin rays and dentition of the jaws, show considerable overlap with certain groups of species of *Apogon*. My recent studies indicate that *Archamia* is most closely related to the genus *Apogon*. In view of the many species of *Apogon* and the lack of a comprehensive understanding of this genus, it is probably best to retain *Archamia* until a thorough study of *Apogon* has been completed. Certainly there are greater differences between various groups of species of the genus *Apogon* than exist between species of these two genera. I hesitate to make generic changes without a more comprehensive knowledge of the species of this family than I have at present. *Archamia* may be distinguished from *Apogon* by a combination of characters: In *Archamia*, anal rays II, 12 to 18 (anal fin rays II, 12 to 13 in *Apogon gracilis* Bleeker and *Apogon mentalis* Evermann and Seale); spines in spinous dorsal VI; vomer and palatines with villiform teeth; anterior margin of preopercle not serrated; posterior margin of preopercle serrated; total number of gill rakers 19 to 24; lateral line complete; caudal fin emarginate to moderately forked; villiform teeth on vomer and palatines in a single row; villiform teeth of upper jaw in a narrow band, those of lower jaw in a narrow band anteriorly, becoming a single row posteriorly (this type of dentition is also characteristic of the *Apogon bandanensis* group).

The literature concerning the species of *Archamia* is extremely confusing. At least 11 specific names can probably be referred to this genus, 5 of which are now placed in synonymy. Most of these species were described with little detail, the critical characters were not analyzed, and the diagnoses were so incomplete as to render the accounts indistinguishable and useless. Six distinct species are herein recognized. The genus is found in the tropical and subtropical marine waters of the Indo-Pacific, from the east African coast to islands of Oceania, but is not yet known from the Hawaiian Islands.

No significant differences were found in an analysis of the following characters for all the species: Lateral line scales ranging from 22 to 26; scales above the lateral line 2; scales below the lateral line 6 or 7; dorsal fin rays VI–I, 9; pectoral rays 13 to 15. The key summarizes the salient differences among the species.

KEY TO THE SPECIES OF ARCHAMIA

1*a*. Body with narrow horizontal stripes in preserved specimens, situated along the middorsal line, dorsolaterally and on midside of body; soft anal rays range from 12 to 13; round, blackish spot at base of caudal fin about equal to size of pupil ---------- **A. buruënsis** (Bleeker)

1*b*. Body without horizontal stripes in preserved specimens; soft anal rays range from 13 to 18; spot, at base of caudal, variable in size and sometimes obsolete.

2*a*. A broad, brownish-black, slightly oblique band encircling body and extending from soft dorsal to belly, its horizontal width about 1.5 to 2.5 in head length; no dark humeral spot at junction of gill opening and body, and no dark spot on body just posterior to opercular flap; soft anal rays range from 14 to 16; brownish-black caudal spot smaller than diameter of pupil ---------- **A. zosterophora** (Bleeker)

2*b*. No band present; a black humeral spot or dusky spot on body just posterior to operculum; soft anal fin rays range from 16 to 18.

3*a*. A dusky, diffuse spot or blotch more or less irregular, and deeper than wide, on body just posterior to opercular flap and below lateral line; a diffuse, dark-brown to blackish circular spot at base of caudal fin, its diameter about equal to diameter of eye.
A. dispilus, new species

3*b*. An intense, circular to squarish, black humeral spot at junction of gill opening and body, the lateral line passing through middle of spot; an intense, sharp, round, black spot at midbase of caudal fin, its diameter slightly larger than pupil and twice in diameter of eye.
A. biguttata, new name

2*c*. No band on body; no dark humeral spot or dusky spot on body just posterior to operculum; brownish-black spot at base of caudal fin larger than diameter of pupil, but usually smaller than diameter of eye, sometimes diffuse to obsolete.

4*a*. Number of soft anal rays averages higher than 16, ranges from 15 to 18; total number of gill rakers averages fewer than 21; total number of gill rakers minus number of soft anal rays equals 5 or fewer; spot at base of caudal fin dusky, diffuse and large in adults, its vertical diameter about 1.5 in least depth of caudal peduncle.
A. fucata (Cantor)

4*b*. Number of soft anal rays averages fewer than 14, range from 13 to 15; total number of gill rakers averages about 22; total number of gill rakers minus number of soft anal rays equals 7 or more; spot at base of caudal fin usually intensely developed, blackish and smaller, about 2.0 to 2.5 in least depth of caudal peduncle, proportionately smaller in young.

A. lineolata (Cuvier and Valenciennes)

ARCHAMIA BURUËNSIS (Bleeker)

Apogon buruënsis BLEEKER, 1856a, p. 394 (type locality, Kajeli, Bouro).
Amia buroënsis BLEEKER, 1873–76, vol. 7, p. 102; 1876–77, vol. 8, pl. (75) 353, fig. 2.

Specimens studied.—U.S.N.M. No. 112111, 43 specimens, 25 to 53 mm., May 20, 1908, below mouth of Min River, Cotabato, Mindanao, Philippine Islands; U.S.N.M. No. 112112, 1 specimen, 62 mm., August 6, 1906, below mouth of Monucan River, Mindanao; U.S.N.M. No. 112113, 1 specimen, 43 mm., March 17, 1909, Port Dupon, Leyte Island, Philippine Islands; U.S.N.M. No. 112114, 3 specimens, 53 to 65 mm., April 2, 1909, Mantaquin Bay, Palawan Island, Philippine Islands; U.S.N.M. No. 112115, 1 specimen, 14 mm., August 8, 1908, China Sea, (lat. 20°31′ N., long. 115°49′ E.); U.S.N.M. No. 112116, 12 specimens, 49 to 63 mm., December 10, 1909, Tifu Bay, Bouru Island, Moluccas Islands; (all specimens collected by the *Albatross* expedition).

Description.—This species is comparatively more elongate and less deep than all other members of the genus. This is particularly evident in the smaller specimens. The following measurements were taken from 7 specimens ranging from 36 to 63 mm. in length: Body depth 2.5 to 3.1; head length 2.3 to 2.5; head depth 3.4 to 4.0; length of caudal peduncle 4.0 to 4.2, all in standard length. Eye 3.2 to 3.8; upper jaw 2.1 to 2.2; depth of caudal peduncle 2.5 to 3.0; snout 4.8 to 4.9, all in length of head.

The total number of gill rakers ranges in 11 specimens from 21 to 23 (table 3).

Color in alcohol.—Head and body brownish; scattered brownish-black, pepperlike spots on snout, top and sides of head, and on chin; three narrow blackish horizontal stripes on head and body; a middorsal stripe extends from occiput to origin of spinous dorsal fin, appearing faintly at base of spinous and soft dorsal fin and ending in a spot at end of last ray of soft dorsal fin; a dorsolateral stripe begins on each side of snout, passing just above eye and through lateral line on anterior portion of body, and then to dorsolateral portion of caudal peduncle, where it gradually fades and becomes obscure; the midbody stripe begins at tip of snout, passes through middle of eye and extends along midbody area to spot at midbase of caudal fin; a faint stripe begins at origin of anal, passing on each side of anal fin, and extends to about the procurrent rays of caudal fin on the lowermost portion of

caudal peduncle, where stripes on each side nearly join; an intense brownish-black, circular to oval spot present at midbase of caudal fin, its horizontal diameter about equal to diameter of pupil.

Range.—Philippine and eastern East Indies Islands, China Sea off northwest Luzon and New Guinea (Macleay, 1884, p. 252).

Remarks.—The only species of *Archamia* having horizontal stripes on the body, it is further characterized by having the lowest anal count and a more slender body, resembling *Apogon gracilis* and *Apogon mentalis* in the latter two characters. The *Apogon gracilis* and *A. mentalis* group are distinguished from *buruënsis* in having a higher number of gill rakers, 25 to 28, and having both margins of preopercle smooth.

No specimens contained buccal ova although the ova were well developed in female specimens about 60 mm. in length.

ARCHAMIA ZOSTEROPHORA (Bleeker)

Apogon zosterophora Bleeker, 1856b, p. 36 (type locality, Manado, Celebes).
Amia zosterophora Bleeker, 1873–76, p. 103, Perc. 35, tab. 313, fig. 2.

Specimens studied.—U.S.N.M. No. 123386, 2 specimens, 29 and 49 mm., December 1944, Tanamera Bay, New Guinea (Lt. Otis Barton); U.S.N.M. uncataloged collections, several hundred specimens ranging in length from 28 to 68 mm., collected in 1908 and 1909 in the East Indies and Philippine Islands (*Albatross* expedition). These collections were reported on by Fowler and Bean (1930, pp. 117–119).

Description.—In addition to the characters listed in the key, *zosterophora* has a slightly lower number of gill rakers (range from 19 to 22, table 3) than the other species of the genus. The body is more deeply proportioned than that of *buruënsis*, but in this respect it is very similar to all the other species.

Color in alcohol.—Head and body tan; cheeks and opercles iridescent silvery tan; fins transparent except some dusky in most specimens on lower half of soft dorsal fin. Three color marks, each varying in intensity, make this species extremely conspicuous. These are (1) a wide brownish bar extending from tip of snout to anterior margin of middle portion of eye; (2) a broad, brownish-black, nearly vertical band (slightly oblique and sloping dorsoventrally toward the head), its horizontal width at the midbody area about 1½ to 2½ in length of head, and almost completely faded in some specimens; and (3) an intense, small, round brownish-black spot at midbase of caudal fin. Fowler and Bean (1930, pp. 116–117) present descriptions of colors in life and a good illustration (Fowler, 1918, p. 29).

Range.—Known from the East Indies Islands (Bleeker, 1856b, p. 36; Weber, 1913, p. 236), Philippine Islands (Fowler, 1918, p. 28; Fowler and Bean 1930, p. 117), New Guinea (Macleay, 1883, p. 235), western

Caroline Islands (Herre, 1935, p. 164), and the Solomon Islands (Herre, 1936, p. 137).

Remarks.—A single male specimen was found with ova in the buccal cavity.

ARCHAMIA DISPILUS, new species

PLATE 17, *c*

Archamia macropteroides EVERMANN and SEALE, 1907, p. 74.
Amia bleekeri FOWLER and BEAN, 1930, p. 110 (in part).

Holotype.—U.S.N.M. No. 112041, a specimen, 58 mm. in standard length, collected January 29, 1910, in Soo Wan Bay, Formosa, by the *Albatross* expedition.

Paratypes.—U.S.N.M. No. 112077, 5 specimens, 53 to 68 mm., taken with the holotype and bearing same data; U.S.N.M. No. 112078, 1 specimen, 57 mm., January 25, 1910, Kwa Siang Bay, Formosa; U.S.N.M. No. 112080, 1 specimen, 63 mm., June 13, 1909, Butauanan Island, Philippine Islands; U.S.N.M. No. 112079, 1 specimen, 57 mm., May 9, 1908, Generale Island, off northeast coast of Mindanao, Philippine Islands (all collected by the *Albatross* expedition); U.S.N.M. No. 56147, 4 specimens, 36.5 to 58 mm., 1903, Bacon, Sorsogon Province, Luzon Island, Philippine Island (C. J. Pierson); U.S.N.M. No. 126368, 3 specimens, 54 to 63 mm., bearing same data as above.

Description.—This description is based on the holotoype and paratypes listed above. The counts are recorded for the holotype, followed in parentheses by the average and range of counts taken from 15 paratypes. Where counts for the paratypes are identical with those of the holotype, but one number is given.

Dorsal rays VI–I,9; anal rays II,17 (II,16.5: II,16 to II,18); pectoral rays, 14 (14.1: 14 to 15); pelvic rays I,5; branched caudal rays 8,7; lateral line scale rows 26 (24.8: 24 to 26); scale rows above lateral line 2; scale rows below lateral line 6 (6.5: 6 to 7); gill rakers 2,4+1+15,0 (range 1 or 2 rudiments, 3 or 4 developed rakers +1+14 to 16 developed rakers, 0 or 1 rudiments; total count averages 21.1).

Measurements, expressed in thousandths of the standard length, are given for the holotype and 4 paratypes in table 1, and compared with *A. biguttata.*

First spine of spiny dorsal about two-fifths length of second; second spine longest, about 1¼ times longer than diameter of eye, but only slightly longer than third spine; second anal spine slightly longer than diameter of eye, first anal spine short, about one-fifth length of second spine; posterior margin of preopercle finely serrated, especially lower edge, anterior margin smooth; ctenoid scales with 8 to 12 radii; upper jaw reaches vertical drawn through middle of eye; lateral line complete; longest gill raker about twice longer than longest filament, and twice in diameter of eye.

Teeth in lower jaw short, conical, directed inward and arranged in two more or less regular rows anteriorly and one row posteriorly; teeth of upper jaw short and conical, anteriorly, and arranged in one to two irregular rows followed by a wide band of villiform teeth posteriorly.

Body deep and compressed (table 1); snout rounded; jaws oblique; pectoral fins pointed; contour of soft dorsal fin rounded; anal fin apparently falcate; caudal fin emarginate; depressed spiny dorsal just touches anterior base of soft dorsal; pelvic fins reach beyond vent but not to origin of anal fin.

TABLE 1.—*Measurements in thousandths of the standard length of two species of* Archamia

Character	*dispilus*		*bigguttata* [1]
	Holotype	4 paratypes [2]	5 specimens
Standard length, mm	58	62 (57–68)	60 (56–63)
Greatest body depth	413	[3] 413 (403–424)	439 (425–455)
Body width	143	140 (121–152)	141 (131–147)
Head length	381	377 (371–386)	386 (375–394)
Head depth at occiput	349	336 (309–356)	376 (361–393)
Length of caudal peduncle	206	193 (170–207)	204 (189–224)
Least depth of caudal peduncle	159	153 (141–162)	153 (143–164)
Length of longest pectoral ray	302	287 (279–301)	306 (299–312)
Length of second spine of spinous dorsal	182	157 (140–182)	154 (143–168)
Diameter of eye	127	127 (114–135)	133 (127–134)
Length of upper jaw	190	186 (175–191)	184 (175–189)
Length of snout	80	81 (73–93)	83 (79–89)
Least width of bony interorbital	95	91 (88–95)	97 (95–100)
Tip of snout to origin of spinous dorsal fin	412	413 (403–424)	426 (417–437)
Tip of snout to origin of anal fin	635	610 (592–633)	606 (585–617)
Tip of snout to insertion of pectoral fins	381	373 (354–391)	391 (377–401)
Tip of snout to insertion of pelivc fins	381	383 (369–406)	406 (394–418)
Tip of snout to anal opening	538	535 (516–543)	540 (532–552)

[1] From the Philippine Islands.
[2] From Formosa and the Philippine Islands.
[3] The average value is followed by the range of variation in parentheses.

Color in alcohol.—Body and head brownish with numerous fine dark-brown pepperlike spots, especially abundant on chin, snout, cheeks, opercles, and midside of body; a large, diffuse, circular dark-brown to blackish spot at base of caudal fin, its diameter almost equal to depth of caudal peduncle and about equal to diameter of eye; an irregular dark-brown spot or blotch just below lateral line and posterior to opercular flap; basal portion of caudal fin with fine, scattered, brown dots; remainder of fins transparent.

Named *dispilus* in reference to the two dark spots on the body.

Range.—Formosa and the Philippine Islands.

ARCHAMIA BIGUTTATA, new name

PLATE 17, *d*

Amia macropterus BLEEKER, 1874, pp. 72–74; 1873–76, p. 103; 1876–77, Perc. 68, tab. 346, fig. 2, preoccupied by *Apogon macropterus* (non Bleeker) Cuvier and Valenciennes, 1828, p. 160=*Apogon lineolatus* Cuvier and Valenciennes, 1828, p. 160.

Amia bleekeri FOWLER and BEAN, 1930, p. 110 (in part).

Specimens studied.—U.S.N.M. No. 56156, 17 specimens, 51 to 62 mm., Bacon Island, Philippine Islands (received from the Philippine Commission); U.S.N.M. No. 112137, 2 specimens, November 9, 1909, Talisse Island, Celebes; U.S.N.M. No. 112138, 1 specimen, November 10, 1909, Limbe Strait, Celebes; U.S.N.M. No. 112139, 1 specimen, November 17, 1909, Gulf of Tomini, Benang Unang Island, Celebes; U.S.N.M. No. 112140, 1 specimen, December 21, 1909, Tana Keke, Celebes; U.S.N.M. No. 112141, 2 specimens, December 29, 1909, Libani Bay, Celebes; U.S.N.M. No. 112142, 2 specimens, November 28, 1909, Makyan Island, Moluccas Islands; U.S.N.M. No. 112143, 3 specimens, November 29, 1909, Makyan Island, Moluccas Islands; U.S.N.M. No. 112144, 4 specimens, December 12, 1909, Tomahu Island, Moluccas Islands; U.S.N.M. No. 112145, 2 specimens, December 10, 1909, Boero Island, Tifu Bay, Moluccas Islands; U.S.N.M. No. 112146, 5 specimens, December 9, 1909, Boero Island, Moluccas Islands; U.S.N.M. No. 112147, 1 specimen, November 25, 1909, Sea of Ternate, Tidore Island, Moluccas Islands; U.S.N.M. No. 112148, 4 specimens, June 13, 1909, Butauanan Island, Luzon, Philippine Islands; U.S.N.M. No. 112149, 1 specimen, June 22, 1909, Rapurapu Island, Luzon, Philippine Islands; U.S.N.M. No. 112150, 1 specimen, May 9, 1909, Dasol Bay, Luzon, Philippine Islands; U.S.N.M. No. 112151, 1 specimen, August 3, 1909, Mahinog, Camiguin Island, Philippine Islands; U.S.N.M. No. 112152, 1 specimen, July 27, 1909, Casagoran, Homonhon Island, Philippine Islands; U.S.N.M. No. 112153, 1 specimen, April 9, 1909, Bisucay Island, Luzon, Philippine Islands; U.S.N.M. No. 112154, 1 specimen, June 7, 1908, Batangas Market, Luzon, Philippine Islands; U.S.N.M. No. 112155, 1 specimen, April 5, 1909, Puerto Princesa, Palawan, Philippine Islands; U.S.N.M. No. 112156, 3 specimens, December 21, 1908, Bolalo Bay, Palawan, Philippine Islands (specimens in U. S. National Museum, Nos. 112137 to 112156, range from 31 to 66 mm.); U.S.N.M. No. 112157, 5 specimens, 43 to 60 mm., January 3, 1909, Port Ciego, Balabac, Philippine Islands; U.S.N.M. No. 112158, 25 specimens, 47 to 57 mm., July 29, 1909, San Roque, Leyte, Philippine Islands; U.S.N.M. No. 112159, 34 specimens, 32 to 46 mm., June 17, 1909, Maagnas, Lagonoy Gulf, Luzon, Philippine Islands; U.S.N.M. No. 112160, 40 specimens, 34 to 40 mm., May 10, 1909, Bolinao Bay, Luzon, Philippine Islands (U.S.N.M. Nos. 112137 to 112160 were col-

lected by the *Albatross* expedition); U.S.N.M. No. 111964, 1 specimen, 37 mm., June 4, 1902, Apia, Samoa (Jordan and Kellog).

Description.—The head and body proportions and the number of fin rays and gill rakers are nearly identical to those of *A. dispilus* (tables 2 and 3).

Color in alcohol.—Head and body tan to brown with some light-bluish silvery iridescence on cheek, opercle, and side of body; some fine, scattered pepperlike brown spots on sides of head and a few on the body; a broad, dark-brown, vertical band, its greatest width slightly exceeding diameter of pupil, extends from lower margin of eye to basal margin of anterior preopercle; the most significant character present in this species and absent in all other members of the genus is the presence of a blackish humeral spot at junction of gill opening and body, circular to squarish in shape, its greatest diameter equal to or only slightly larger than diameter of pupil; humeral spot almost always intensely developed (faded but not obscure in about one percent of specimens listed above); a blackish, intense, circular spot at midbase of caudal fin, sometimes faded or completely obscure, its diameter slightly larger than pupil and about twice in diameter of eye.

The name *biguttata* refers to the two dark spots, the humeral spot and the one at the midbase of the caudal fin (pl. 17, *d*).

Range.—East Indies, Philippine and Samoan Islands.

Remarks.—Although Bleeker's account (1874, pp. 72–74) of *Amia macropterus* contains more than one species by the inclusion of such data as the anal fin rays ranging from II, 14 to II, 18 and his statement on the variability of the humeral spot, it is distinctly understood which species he examined from his illustration (1876–77, tab. 346, Perc. tab. 68, fig. 2). His name is unfortunately preoccupied (see synonymy of *Archamia lineolata*, p. 591). The low anal-ray count, II, 13, listed by Cuvier and Valenciennes (1828, p. 160) for *Apogon macropterus*, and the absence of mention of a spot at the junction of the gill opening and body, certainly define Bleeker's *macropterus* as a different species. Examination of several collections totaling more than a hundred specimens, from small juveniles to adults, confirmed the constant presence of the well-developed humeral spot on the body at the junction of the gill opening.

The single specimen from Apia, Samoa (U. S. N. M. No. 111964) was taken in the same collection with *Archamia fucata* and *A. lineolata*, but it was apparently overlooked by Jordan and Seale (1906, p. 252). Recent intensive collecting by Schultz and others in the Marshall Islands, as well as in the Phoenix and Samoan Islands (Schultz, 1943), failed to reveal a single specimen, indicating that it is probably not common or does not occur in this area of the Pacific.

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ARCHAMIA FUCATA (Cantor)

PLATE 17, *b*

Apogon fucatus CANTOR, 1850, p. 986 (anal fin rays II, 16; type locality, Sea of Pinang).

Apogon macropteroides BLEEKER, 1852, p. 724 (anal fin rays II, 16 or 17; Lepar Island).

Apogon bleekeri GÜNTHER, 1859, p. 245 (anal fin rays II, 14 to 17; Amboyna) = *Apogon lineolatus* Cuvier and Valenciennes (?), 1828, vol. 2, p. 160.

Apogon notata DAY, 1867, p. 936 (anal fin rays II, 16; Madras).

Archamia kagoshimana DÖDERLEIN (MS.), *in* Steindachner and Döderlein, 1884, p. 3 (anal fin rays II, 16; Kiusiu Island).—JORDAN and SNYDER, 1901, p. 907.

Archamia lineolata JORDAN and SEALE, 1906, p. 252.—FOWLER and BEAN, 1930, pp. 113–117 (in part).—SCHULTZ, 1940, p. 412; 1943, p. 94.

Specimens studied.—U. S. N. M. Nos. 149404 to 149431 and 149433 to 149452, totaling 685 specimens, 18 to 27 mm., 1908 and 1909, East Indies and Philippine Islands (*Albatross* expedition); U. S. N. M. No. 149432, 2 specimens, 52 and 72 mm., January 29, 1910, Hokuko Soo Wan, Formosa (*Albatross* expedition); U. S. N. M. Nos. 52203, 111967, and 126601, totaling 67 specimens, 18 to 56 mm., 1902, Apia, Samoa (Jordan and Kellogg); U. S. N. M. Nos. 142460, 142461 and 142462, totaling 79 specimens, 33 to 57 mm., 1946, Rongelap and Bikini Atolls, northern Marshall Islands (Herald, Brock, and Schultz).

Description.—See discussion that follows description of *lineolata* and data in tables 2 and 3 (pp. 591, 592).

Color in alcohol.—Body and head light tan with fine brown flecks on cheeks, opercles, and sides of body; tip of jaws with some black pigment flecks; small brown spots forming a faint streak extending from the tip of the upper jaw to beneath eye; a large, circular, blackish-brown blotch at base of caudal fin, sometimes diffuse to obsolete, variable in size (smaller in younger specimens), usually a little less in depth than least depth of caudal peduncle but in some small specimens about one-half depth of caudal peduncle; spinous dorsal fin tipped in blackish; remainder of fins transparent; traces of about twenty brown and silvery, narrow, vertical bars in some specimens, usually obsolete.

Range.—Represented in our collections from the East Indies, Philippine, Samoan, and Marshall Islands.

Remarks.—There has been no attempt to compile completely the synonymy of this or the other species included in this paper, for it is considered quite hopeless to do so without having the specimens reported upon in the various literature, critical accounts of the species, or good illustrations. This also applies to the "range" given for each species.

ARCHAMIA LINEOLATA (Cuvier and Valenciennes)

PLATE 17, *a*

Apogon lineolatus CUVIER and VALENCIENNES, 1828, p. 160 (anal fin rays, II, 14; type locality, Red Sea).
Apogon macropterus CUVIER and VALENCIENNES, 1828, p. 160 (anal fin rays II, 13; Java).
Apogon zeylonicus CUVIER and VALENCIENNES, 1829, p. 491 (anal fin rays II, 14; Ceylon).
Apogon argenteus VALENCIENNES, 1832, p. 60 (anal fin rays II, 14; Vanicolo).
Archamia bleekeri GÜNTHER, 1859, p. 245 (anal fin rays II, 14 to 17; Amboyna) =*Apogon fucatus* Cantor (?), 1850, p. 986.

Specimens studied.—U.S.N.M. No. 57944, 5 specimens, 18 to 21 mm., Zamboanga, Mindanao, Philippine Islands (E. A. Mearns); U.S.N.M. Nos. 112117–112128, 23 specimens, 41 to 64 mm., 1908–09, East Indies and Philippine Islands (*Albatross* expeditions); U.S.N.M. No. 126601, 7 specimens, 40 to 53 mm., 1902, Apia, Samoa (Jordan and Kellogg).

Color in alcohol.—General coloration about the same as in *fucata*, except that the circular black spot at the midbase of the caudal fin is smaller and more intensely developed. Its greatest diameter measures about 2.0 to 2.5 in the least depth of the caudal peduncle. This spot is proportionately smaller in younger specimens, measuring about 2.5 to 3.5 in the least depth of the caudal peduncle.

Range.—Red Sea, East Africa to East Indies, Philippine Islands, Samoa, and probably other groups of islands of Oceania.

TABLE 2.—*Frequency distribution of the number of soft anal fin rays for species of* Archamia

Species and locality	Soft anal rays						
	12	13	14	15	16	17	18
biguttata, Philippine Islands	------	------	------	------	14	8	------
dispilus, Formosa and Philippine Islands	------	------	------	------	8	3	2
buruensis, Philippine Islands	9	7	------	------	------	------	------
lineolata, East Indies and Philippine Islands	------	7	31	3	------	------	------
Samoa	------	1	4	3	------	------	------
fucata, East Indies and Philippine Islands	------	------	------	1	15	6	1
Formosa	------	------	------	------	------	1	------
Northern Marshall Islands	------	------	------	------	7	6	------
Samoa	------	------	------	------	7	12	2
zosterophera, Philippine Islands	------	------	6	7	3	------	------

Remarks.—For some years *Archamia fucata* has been considered synonymous with *Archamia lineolata*. Bleeker's account (1874, p. 72) and figure (1876–77, tab. 346, perc. tab. 68, fig. 2), as well as that of Weber and de Beaufort (1929, p. 347), confound even a third species

(*A. biguttata*). *Archamia fucata* and *A. lineolata* are remarkably similar in body form, scutellation, pigmentation, and fin-ray counts, with the exception of the anal fin. A small difference was found also in the gill-raker counts. A summary of the distribution of the number of soft anal fin rays and gill rakers for the species of *Archamia* are given in tables 2 and 3. About 6 percent of the anal fin rays between *fucata* and *lineolata* show an overlap, *fucata* averaging about 2½ rays more. *A. lineolata* averaged about one more developed raker on the upper arch and about one-half raker more on the lower arch. When the number of gill rakers and soft anal fin rays was considered for each of these species, all specimens studied were separated.

TABLE 3.—*The number of gill rakers on the first gill arch for species of* Archamia [1]

Species	Upper right limb [2]					Lower right limb [3]				Total					
	1,3	2,3	3,3	1,4	2,4	13	14	15	16	19	20	21	22	23	24
biguttata	----	4	5	3	2	----	1	7	6	----	2	4	4	4	----
dispilus [4]	----	9	----	2	2	----	3	7	3	----	3	6	3	1	----
buruēnsis	----	----	----	----	11	----	2	6	3	----	----	2	6	3	----
lineolata	----	1	2	2	12	----	1	11	5	----	----	6	15	6	1
fucata	----	16	----	----	----	----	5	11	----	----	6	13	----	----	----
Formosa	----	----	1	----	----	----	----	1	----	----	----	----	1	----	----
Northern Marshall Islands	----	10	----	----	----	----	3	7	----	----	3	7	----	----	----
Samoa	----	4	1	----	----	----	3	2	----	----	3	1	1	----	----
zosterophera	2	4	6	1	1	2	9	3	----	3	3	6	2	----	----

[1] All collections from the Philippine Islands unless indicated otherwise.
[2] The rudiment count precedes the developed-raker count and is separated from it by a comma.
[3] A single tiny rudiment was sometimes present and was included in the count. The raker at the angle was included in the total count only.
[4] From Formosa and Philippine Islands.

A character index formed by subtracting for each individual specimen the number of soft anal fin rays from the total number of gill rakers distinctly separates *fucata* from *lineolata*, as indicated in the following frequency distribution:

Species	Total number of gill rakers minus number of soft anal rays							
	3	4	5	6	7	8	9	10
fucata	8	15	12	--------	--------	--------	--------	--------
lineolata	--------	--------	--------	--------	4	16	9	1

Color differences were observable when a series of specimens of each species were simultaneously compared. In *Archamia lineolata* (pl. 17, *a*) the black caudal spot is smaller and more intensely developed

than in *A. fucata* (pl. 17, *b*). The general body color appears to be a slightly lighter tan in *fucata* and more dusky in *lineolata*. The caudal spot varies to such an extent in intensity that in a single collection certain specimens show gradations from plainly discernible to faintly visible spots, or they may be obsolete. Both these species are widely distributed. The synonymy listed for each illustrates the confusion among many of the earlier workers. Descriptions were only general and meager, and often of a single specimen, and the salient characters were not critically studied. The variability of certain color marks was not understood. For example, the spot at the base of the caudal fin varies so considerably in intensity as to be completely obscure in some specimens of *fucata* and *lineolata*, and even in a few specimens of *A. biguttata*, yet the humeral spot is always intensely developed in *biguttata*. Thus, such writers as Jordan and Snyder (1901, p. 907) recognized *A. kagoshimana*, a manuscript name of Döderlein (*in* Steindachner and Döderlein, 1884, p. 3), on the basis of the absence of the caudal spot in a single specimen and the fact that it was taken in the Japanese faunal area.

Prof. L. Bertin, Muséum National d'Histoire Naturelle, Paris, sent word that no type material of *Apogon macropterus* Cuvier and Valenciennes is at that museum, and that probably no type was designated, as Cuvier and Valenciennes used a manuscript name of Kuhl and Van Hasselt. From the above discussion of the *fucata-lineolata* complex and the distribution of the anal-fin-ray counts (table 2), it is almost certain that *Apogon macropterus* Cuvier and Valenciennes equals *Apongon lineolatus* Cuvier and Valenciennes. Günther's description (1859, p. 245) of *Apogon bleekeri* contained no diagnostic data. The number of anal fin rays was said to range from II, 14 to II, 17. This distribution overlaps that of *fucata* and *lineolata*, and it is doubtful which species he examined, since no color marking is indicated other than the presence of a caudal spot. Dr. E. Trewavas, British Museum, has informed me that the type of *Apogon bleekeri* Günther cannot be located.

I am unable to determine the status of *Archamia macroptera* and *A. lineolata* of Smith (1949, pp. 208–209, pl. 23, figs. 489 and 490). Prof. J. L. B. Smith informs me that the two horizontal body stripes of his figure of *macroptera* are life colors and are "virtually invisible" after a day of preservation. The anal-ray count that he reported for this species (ibid., p. 208), II, 14 to 17, represented the range of his data and also that of "Day (Fishes of India, pt. 1, p. 64, pl. 17, fig. 4, 1875) and Fowler" (publication not given). Three adult specimens received from Smith, collected in Delagoa Bay, East Africa (U.S.N.M. No. 112206) have anal fin rays numbering II, 14 (2 specimens) and II. 15 and gill rakers numbering 5+1+16. These statistics correlate

with my discussion of *A. lineolata.* The blackish, circular spot at the base of the caudal fin in Smith's specimen is distinct and small, its diameter about four times in the least depth of the caudal peduncle, so it is perceptibly smaller than in specimens of *lineolata* from the East Indies and Philippine Islands. His specimens may represent a distinctly new form. The spot in Smith's figure of *macropterus*, however, measures about three times in the depth of the caudal peduncle.

The account of *lineolata* by Smith (ibid., p. 209) lists the anal fin rays as ranging from II, 13 to 17 and his figure may be interpreted as having either II, 14 or II, 15 anal rays, with a distinct spot at the base of the caudal fin, its depth about three times in the least depth of the caudal peduncle. The range of the anal fin rays almost certainly refers to both *lineolata* and *fucata.* The size and intensity of the caudal spot are characteristic of *lineolata.* Sufficient specimens are not available from the east African area to determine whether his account refers to *lineolata*, *fucata*, or both.

STUDIES OF THE APOGON BANDANENSIS GROUP

This group is distinguished from other species of *Apogon* by the combination of the following characters: Dorsal fin rays VII–I, 9; anal rays II, 8; pectoral rays 12 to 14; lateral line scales 22 to 26; total number of gill rakers ranging from 23 to 30; palatines with villiform teeth; posterior margin of preopercle serrated, anterior margin of preopercle not serrated; lateral line complete; third spine of spinous dorsal longest; caudal fin emarginate or slightly forked; a band, saddle, or saddlelike spot on peduncle at base of caudal fin; a characteristic mark, narrow and elongate or triangular shaped (fig. 105, *a* and *b*) from eye to angle of anterior margin of preopercle; body, head, and fins otherwise without stripes or bars.

The data derived from a careful study of collections in the United States National Museum indicate that more than two species were confused and included in this group by relatively recent workers. An examination of the collections concerned in such studies as Fowler and Bean (1930, pp. 40–44), Jordan and Seale (1906, pp. 239–240), and Schultz (1943, pp. 92 and 95) revealed the presence of more than one species. Four species are now recognized. The group is distinctly divisible into two categories: 1, Species with a large triangular mark below the eye (fig. 105, *a*); 2, a species with a narrow, elongate almost rectangular mark below the eye (fig. 105, *b*). The following species with a triangular mark below the eye are recognized: *Apogon erdmani*, new species, *Apogon bandanensis* Bleeker, and *Apogon savayensis* Günther. In the latter category *Apogon nubilus* Garman

is placed. The significant characters differentiating the species of this group are listed in tables 5 and 6, discussed in the accounts of the species, and portrayed on plates 18, *a* to *c*, and 19.

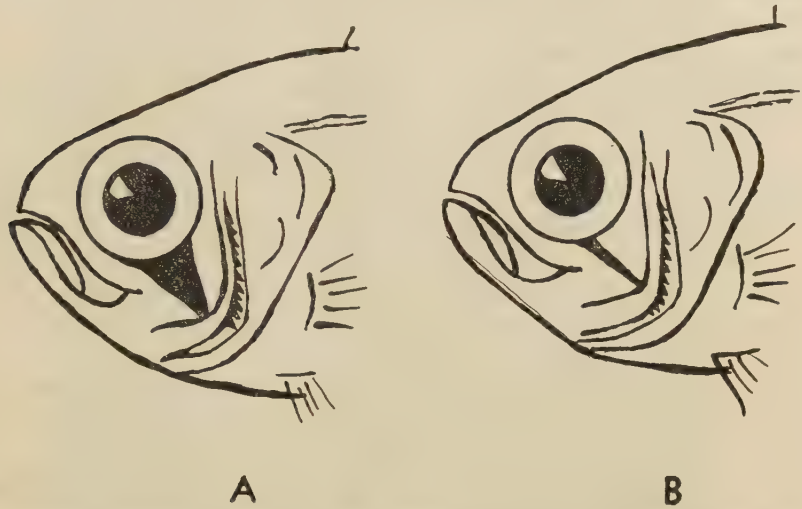


FIGURE 105.—Sketch showing: *a*, Triangular cheek mark in *Apogon savayensis* Gunther; *b*, narrow elongate mark in *A. nubilus* Garman.

APOGON ERDMANI, new species

PLATE 18, *a*

Holotype.—U.S.N.M. No. 147518, a female specimen, 60 mm. in standard length, collected by Donald S. Erdman, July 2, 1946, at Jidda, Red Sea.

Paratypes.—U.S.N.M. No. 112040, 21 specimens, 39 to 59 mm. in standard length, taken with holotype and bearing same data. U.S.N.M. No. 147522, a specimen 47 mm. in standard length, collected by Erdman and Azizz, July 14, 1948, at Jidda, Red Sea.

Description.—This description is based on the holotype and paratypes listed above. The counts are recorded for the holotype and followed by data from 10 paratypes in parentheses. When the counts for the paratypes are identical with those of the holotype, but one number is given. Dorsal rays VII–I, 9; anal rays II, 8; pectoral rays 13; lateral line scale rows 23 (23 to 24); scales above lateral line 2; scales below lateral line 6. Measurements for the holotype and 7 paratypes are presented in table 4.

Gill rakers 8+1+20 (6 to 8+1+18 to 21, total 25 to 30); third spine of spiny dorsal longest, about twice in head length; second spine less than one-half length of third spine; first spine minute, less than one-fifth length of second spines; second anal spine about equal to length of third dorsal spine; posterior margin of preopercle finely

serrated, anterior margin smooth; no suborbital serrations; scales ctenoid with 10 to 12 radii in anterior field only; upper jaw reaches vertical drawn through middle of eye; lateral line complete; longest gill raker twice as long as longest filament, and about twice in diameter of eye; a single, flat opercular spine.

Villiform teeth in jaws, vomer, and palatines; those in upper jaw in a wide band; a wide patch or band anteriorly in lower jaw, reduced to two irregular rows posteriorly; teeth on vomer in a narrow patch; palatines with a single row; body comparatively deeper in adults; caudal fin emarginate; contour of soft dorsal and anal fin convexly rounded, pectoral moderately rounded; depressed spiny dorsal fin reaches origin of soft dorsal in some specimens; pelvic fins extend beyond vent, reaching anal origin in some specimens.

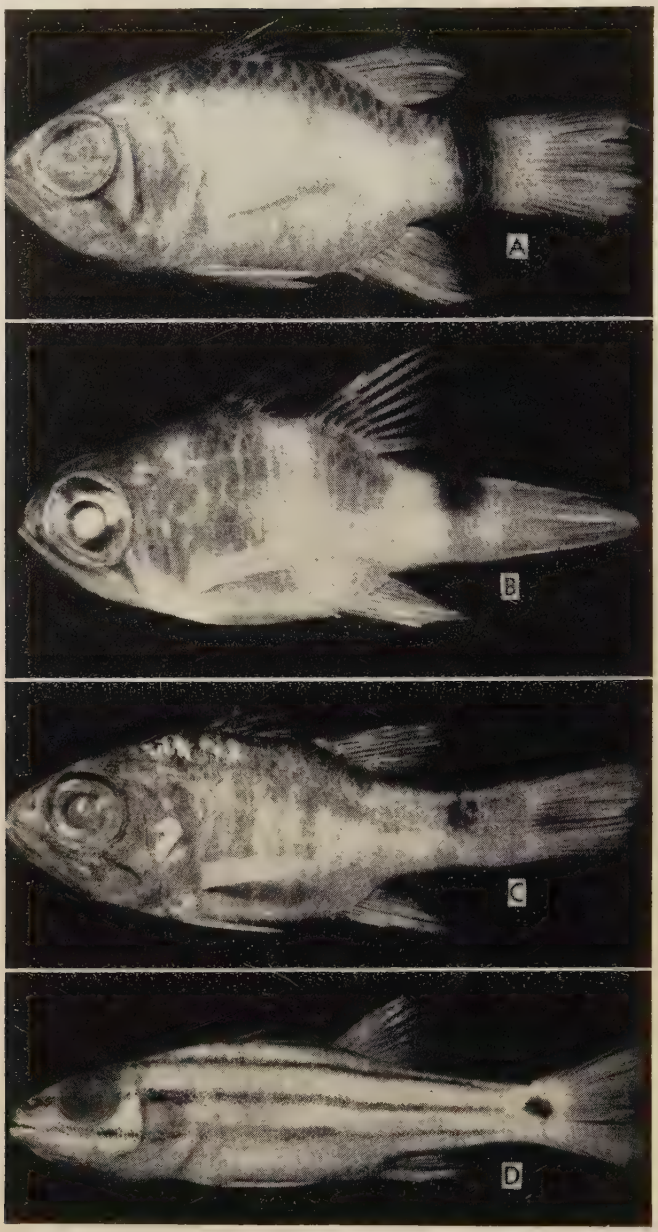
TABLE 4.—*Measurements expressed in thousandths of the standard length of* Apogon erdmani

Measurement	Holotype	Paratypes (U.S.N.M. No. 112040)						
Standard length, mm	60	58	54	43	39	59	55	44
Sex	♀	♂	♂	♂	♂	♀	♀	♀
Greatest body depth	454	491	482	477	433	491	500	437
Body width	183	214	204	186	179	214	182	184
Head length	434	431	463	466	433	431	418	425
Head depth at occiput	366	362	404	372	359	362	382	368
Length of caudal peduncle	233	250	241	221	231	250	245	241
Least depth of caudal peduncle	183	190	204	186	179	190	191	184
Length of longest pectoral ray	267	284	306	279	282	284	291	299
Length of third spine of spinous dorsal	175	190	185	209	192	190	200	214
Diameter of eye	167	172	185	174	179	172	163	172
Length of upper jaw	171	233	232	221	231	233	227	214
Length of snout	92	86	93	93	103	86	82	92
Least width of bony interorbital	117	103	110	116	103	103	109	115
Tip of snout to origin of spinous dorsal fin	442	448	463	466	433	448	452	437
Tip of snout to origin of anal fin	708	690	685	698	680	690	691	690
Tip of snout to insertion of pectoral fin	404	397	426	395	410	397	391	414
Tip of snout to insertion of pelvic fin	425	431	426	442	433	431	418	437
Tip of snout to anal opening	666	621	667	651	628	621	654	652

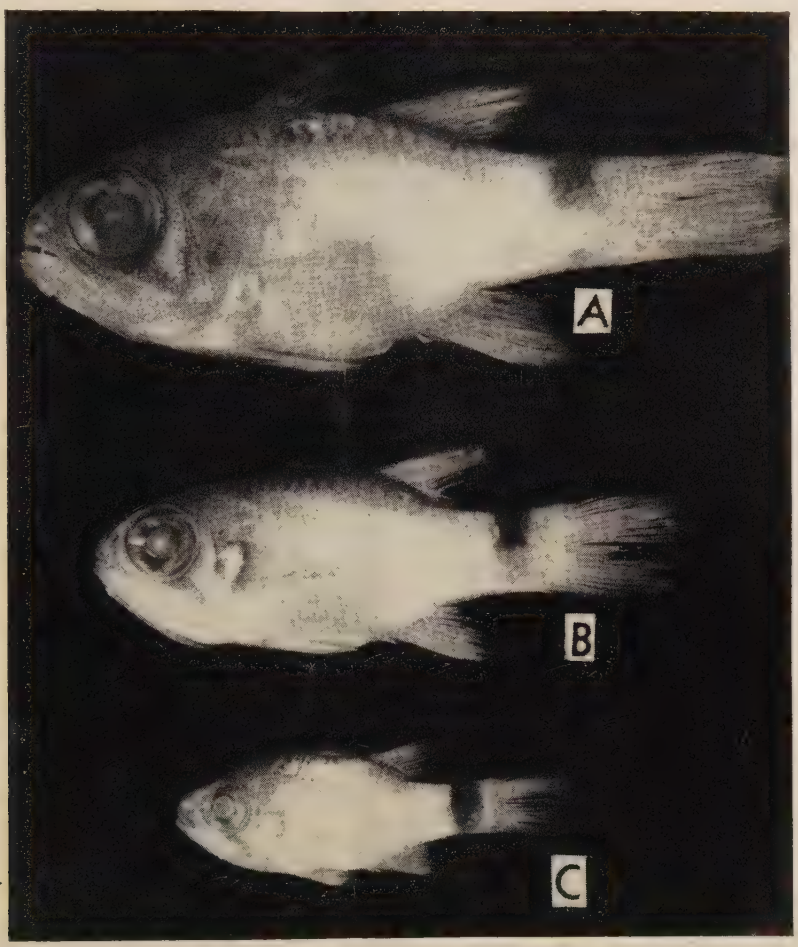
Color in alcohol.—Body and head light to dusky in smaller specimens to dusky or blackish in larger ones; a conspicuous black triangular mark extending from below eye to angle of anterior margin of preopercle; a characteristic black band encircling caudal peduncle at base of caudal fin; pectoral and pelvic fins transparent to dusky; dorsal, anal, and caudal fins dusky; Donald S. Erdman, collector of these specimens, reported to me that this species possessed no other outstanding colors when alive, and that the dusky to blackish body colors were somewhat lighter and silvery.

Named *erdmani* in honor of the collector, Donald S. Erdman.

The location and intensity of certain spots found on the bodies of four species of *Archamia:* A, *A. lineolata* (Cuvier and Valenciennes), with moderately developed spot at base of caudal peduncle, 56 mm. in standard length, from Makyan Island, East Indies. B, *A. fucata* (Cantor), with a diffuse spot at base of caudal fin, 53 mm. in standard length, from Bagay Gulf, Philippine Islands. C, *A. dispilus*, new species, holotype, U.S.N.M. No. 112041, 58 mm. in standard length, from Soo Wan Bay, Formosa. Note diffuse spots on body just posterior to opercular flap and at base of caudal fin. D, *A. biguttata*, new name, with intensely developed humeral and caudal pedunclar spots, 60 mm. in standard length, from Luzon, Philippine Islands.



A, *Apogon erdmani*, new species, holotype, U.S.N.M. No. 147518, 60 mm. in standard length, from Jidda, Red Sea. B, *A. bandanensis* Bleeker, 54 mm. in standard length, from Busuanga Island, Philippine Islands. C, *A. nubilus* Garman, 63 mm. in standard length, from the northern Marshall Islands. D, *Paramia bipunctata*, new species, holotype, U.S.N.M. No. 147944, 47 mm. in standard length, from the Persian Gulf.



Apogon savayensis Günther, from the northern Marshall Islands, showing reduction in size of mark at base of caudal fin, from a band in young to a saddle-like mark in adults. A, Adult 71 mm. in standard length. B, Juvenile, 51 mm. in standard length. C, Small specimen, 34 mm. in standard length.

APOGON BANDANENSIS Bleeker

PLATE 18, *b*

Apogon bandanensis BLEEKER, 1854, p. 95 (type locality, Banda Island); 1873–76, p. 82; 1876–77, Perc. 67, tab. 345, fig. 2.
Amia bandanensis FOWLER and BEAN, 1930, p. 40 (in part).

Specimens studied.—U.S.N.M. No. 112129 to 112136, 112161 to 112196, 89 specimens, 36 to 65 mm., collected during 1908–09 in the East Indies and Philippine Islands (*Albatross* expedition).

Description.—The tabulated statistics comparing counts and measurements of various structures among these four species, other than those pertaining to the gill rakers, show little or no differences, and will receive no further treatment. The extent of the development of the serrations on the posterior margin of the preopercle, as well as the development of the villiform teeth of the jaws, is almost identical.

Color in alcohol.—Head and body brown dorsally, light brown ventrally; some coppery-blue iridescence on cheek, opercle, and side of body; a brown triangular mark extending from lower margin of eye to angle of anterior margin of preopercle; sides of body sometimes with narrow, silvery vertical bars, interspaced with wide light-brown bars; two saddles on body, their width about three-fourths in diameter of eye, one passing through spinous dorsal fin and the other through soft dorsal fin; these saddles extend from the fin bases to about midbody area; anterior saddle almost completely faded in about 30 percent of specimens examined; saddle through spinous dorsal (posterior saddle) almost completely faded in about 5 percent of specimens examined; a dark brown saddle over caudal peduncle at base of caudal fin in larger adults, sometimes with traces of a lower portion forming a band; in smaller specimens (under 50 mm.) saddle extends below lateral line forming a complete band, and the portion of band below lateral line is a light brown and not so intensely developed as the more intense, darker brown, upper portion; a conspicuous dark brown streak on the two outer branched caudal rays margined by clear to white color on the unbranched caudal ray; remainder of caudal fin dusky to clear; in about 20 percent of specimens the dark brown outer streak is not present and it is not certain if this is due to fading, immaturity, sexual dimorphism, or a combination of all three factors; the plain, brown caudal fin occurred in the smaller specimens (under 50 mm.) and was found in more females than males in more than 10 specimens of each sex examined; it was also noted that the males had a more intense development of the saddles; these are but tentative assumptions, for too few specimens could be sexed because of their poor preservation and years of storage; in many specimens the outer rays of the caudal fin, as well as of the other fins, were frayed and broken; the pectoral,

pelvic, soft dorsal, and anal fins are clear to slightly dusky; the anterior portion of spinous dorsal dusky to black, remainder of fin clear.

Range.—East Indies and the Philippine Islands.

Remarks.—See *Remarks* under *A. savayensis* (p. 599) for a discussion of the relationships among *bandanensis*, *savayensis*, and *erdmani*.

APOGON SAVAYENSIS Günther

PLATE 19, *a–c*

Apogon savayensis GÜNTHER, 1871, p. 656 (types from Savay, Samoa, and Mando, Celebes; 1873, p. 21, tab. 19, fig. b).
Amia savayensis JORDAN and SEALE, 1906 p. 239.
Amia bandanensis FOWLER and BEAN, 1930, p. 40 (in part).
Apogon bandanensis SCHULTZ, 1943, p. 95 (in part).

Specimens studied.—U. S. N. M. Nos. 112234 to 112241 and 126373, totaling 13 specimens, 48 to 75 mm., all collected during 1908–09 in the East Indies and Philippine Islands by the *Albatross* expedition except No. 126373, which was collected by Pierson in 1903; U. S. N. M. Nos. 142414 to 142417 and 142428, 40 specimens (56 additional specimens not cataloged), 19 to 60 mm., July to September 1946, northern Marshall Islands (Brock, Donaldson, Herald, and Schultz); U. S. N. M. Nos. 126257, 52432, and 58522, totaling 30 specimens, 42 to 70 mm., 1902, Samoan Islands (Jordan and Kellogg); U. S. N. M. No. 82953, 1 specimen, 65 mm., Samoan Islands (Wilkes Exploring Expedition); U. S. N. M. No. 65426, 7 specimens, 67 to 78 mm., February 1904, Manga Reva, Tuamotu Archipelago (*Albatross* expedition); U. S. N. M. No. 82795 and 82796, totaling 3 specimens, 45 to 65 mm., Fiji or Oahu (Wilkes Exploring Expedition).

Color in alcohol.—Body and head light tan to dusky, head more dusky; in some specimens body, laterally, with about six vertical narrow silvery bars, separated by wider dusky bars; these vertical bars are often irregular or may be completely absent; three characteristic markings are: (1) a large triangular or wedge-shaped dark-brown mark extending from below eye to angle or slightly above angle of anterior margin of preopercle (slightly more horizontally directed than in *bandanensis*); (2) a dark-brown saddle at base of caudal fin, not extending below lateral line in adults; this saddle begins in young and juveniles as an almost complete band extending below lateral line and nearly encircles caudal peduncle, but as the specimens increase in size the band gradually atrophies into a saddle; and (3) a conspicuous dark brown streak in the outer two-branched caudal rays; the outermost unbranched caudal ray is usually clear or white and is in contrast with the dark brown streak; pectoral, pel-

vic, soft dorsal, and anal fins clear to slightly dusky; anterior and outer portion of spinous dorsal blackish, remainder of fin dusky to clear; caudal, other than dark brown streak, faintly dusky to clear.

Range.—On the basis of United States National Museum collections, *savayensis* ranges from the Philippine Islands eastward among the islands of Oceania (Marshall, Samoan, Tuamotu, Fiji), where it is commonly taken with *nubilus*.

Remarks.—Examination of more than several hundred specimens of this group from Oceania failed to reveal a single one having the dorsal saddles developed as in *bandanensis*. Some specimens from the Philippine Islands were not determinable, owing chiefly to their small size or faded condition. The young and some juveniles of *savayensis* and *bandanensis* have the caudal saddle, typical of the adults, extending below the lateral line forming a band nearly encircling the peduncle (pl. 19, *a* to *c*). When small specimens of *bandanensis* had the body saddles seriously faded, such specimens could not be distinguished from those of *savayensis* with certainty. Many of these small specimens were distinguished by the caudal band, which in *savayensis* progressively atrophies into a saddle with increase in size of the specimens, but which in *bandanensis* does not completely atrophy, becoming only lighter in color and less distinct in the area below the lateral line.

Some adult specimens from the East Indies and Philippine Islands were also not identifiable because of their faded or intermediate color patterns. Although a considerable overlap occurred in the frequency distributions of the number of gill rakers between *savayensis* and *bandanensis* from these areas (table 5), the consistently higher number found in *savayensis* often aided in separating partially faded specimens. The following adult specimens from the East Indies and Philippine Islands are questionable determinations referred to the species *bandanesis:* U. S. N. M. Nos. 112164, 112169, 112171, 112176, 112177, 112182, 112186, and 112190. The two collections, U. S. N. M. No. 112132 from the Philippine Islands and 123476 from the Solomon Islands, could not be identified. These specimens are intermediate in coloration between *erdmani*, *bandanensis*, and *savayensis*. The caudal fin is a more or less uniform light brown. The first body saddle through the spinous dorsal is absent and a trace of a saddle through the soft dorsal is sometimes present. The caudal peduncle mark sometimes resembles the complete band found in *erdmani*. In some specimens the lower portion of the band below the lateral line is of a lighter color than that portion above the lateral line. The assumption that these three forms might be considered as subspecies

on the basis of these intermediate specimens was discarded. Since these intermediate specimens were taken over a wide area including certain islands of the East Indies, Philippines, and Solomons, one must assume that they represent intergrades between two forms occupying different habitats. A search for ecological data from the literature and *Albatross* records revealed no relationships between color form and habitat, nor were any significant differences found in habitats occupied by the four species. It is suspected that color differences owing to sexual dimorphism may exist in *bandanensis* and this factor may, in part, be associated with these intermediate-colored specimens. More study with freshly collected material from the East Indies and Philippine Islands is required.

A. savayensis probably attains the largest average size of this group, reaching a maximum length of about 80 mm. The young appear to be more elongate and less deep than the young of the other three species.

APOGON NUBILUS Garman

PLATE 18, *c*

Apogon nubilus GARMAN, 1903, pp. 229–230, pl. 1, fig. 1 (type locality, Suva, Fiji Islands).
Amia bandanensis FOWLER and BEAN, 1930, p. 40 (in part).
Apogon bandanensis SCHULTZ, 1943, p. 95 (in part).

Specimens studied.—U.S.N.M. Nos. 147519, 147523, 147524, and 112046, totaling 62 specimens, 14 to 65 mm., July 1948, Red Sea (Erdman); U.S.N.M. Nos. 112197 and 112050 to 112062, totaling 23 specimens, 21 to 71 mm., 1908–09, East Indies and Philippine Islands (*Albatross* expedition); U.S.N.M. Nos. 71562, 7 specimens, 26–42 mm., 1906, Ryukyu Islands (*Albatross* expedition); U.S.N.M. No. 132681, 1 specimen, 30 mm., July 28, 1945, Ryukyu Islands (Simon); U.S.N.M. Nos. 112347 to 112352, totaling 229 specimens, and an additional 86 specimens not cataloged, 9 to 79 mm., 1946–47, northern Marshall Islands (Brock, Donaldson, Herald, Hiatt, and Schultz); U.S.N.M. No. 152947, 2 specimens, 61 and 63 mm., August 20–22, 1949, Likiep Atoll, Marshall Islands (Univ. Washington); U.S.N.M. No. 139811, 3 specimens, 22 to 34 mm., June 1945, Saipan, Marianas (Shroyer and White); U.S.N.M. No. 139811, 34 specimens, 36 to 63 mm., November 26, 1945, Guam, Marianas (Frey); U.S.N.M. No. 139799, 3 specimens, 16 to 22 mm., December 11, 1945, Rota Island, Marianas (Frey); U.S.N.M. No. 150008, 19 specimens, 20 to 30 mm., December 19, 1948, Saipan, Marianas (picked from head of brown *Acropora*) (Cloud, Schmidt, and Flatt); U.S.N.M. No. 151451, 4 specimens, 52 to 64 mm.,

November 29, 1945 and January 8, 1946, Guam, Marianas (Gressitt and Ingram); U.S.N.M. No. 151452, 37 specimens, 42 to 72 mm., December 23, 1945, Guam, Marianas (Gressitt and Frey); U.S.N.M. No. 114973, 4 specimens, 41 to 61 mm., June 3, 1939, Tutuila Island, Samoa (Schultz); U.S.N.M. No. 112047, 11 specimens, 26 to 50 mm., Apia, Samoa (Jordan and Kellogg); U.S.N.M. No. 112048, 11 specimens, 21 to 59 mm., Pago Pago, Samoa (Jordan and Kellogg); U.S.N.M. No. 112198, 6 specimens, 28 to 61 mm., Apia, Samoa (Jordan and Kellogg); U.S.N.M. No. 114974, 47 specimens, 9 to 41 mm., July 8–12, 1939, Hull Island, Phoenix Islands (Schultz); U.S.N.M. No. 114975, 14 specimens, 41 to 64 mm., May 25–26, 1936, Canton Island, Phoenix Islands (Schultz); U.S.N.M. No. 114972, 76 specimens, 34 to 61 mm., May 23–25, 1939, Canton Island (Schultz); M.C.Z. No. 28315, holotype, Fiji Islands.

Color in alcohol.—Body and head dusky to light silvery to dusky brown; some specimens with 6 to 8 vertical silvery bars separated by wider dusky vertical bars; dark mark extending from below eye to angle of preopercle elongate and narrow, about the same width below the eye as at the angle of the preopercle; a diffuse dusky spot at base of caudal fin just above lateral line in adults, never developed over dorsal part of caudal peduncle to form a saddle; sometimes only faintly visible or obsolete; caudal spot diffuse in young and juveniles, located at midbase of caudal fin and equally divided by lateral line in specimens ranging in size up to about 20 mm.; in specimens about 30 to 35 mm. in length the spot begins to migrate dorsally, more of it being above the lateral line than below; fry under 15 mm. have melanophores in 3 to 4 horizontal rows on the body and irregularly scattered on the head; upper portion of membrane of spinous dorsal blackish, more so between third and fifth spines; remainder of spinous dorsal and other fins light dusky to clear.

Color in life.—From Kodachrome transparency taken in the Marshall Islands under the direction of Dr. L. P. Schultz: Body laterally dusky to purple with irregular vertical silvery stripes; belly dusky to silvery with some purple; head deep purple; pectoral fin transparent and colorless; membrane between third to fifth spine of spiny dorsal light bluish, remainder dusky to light brown; soft dorsal and anal transparent to light brown, darker brown near bases; anal light brown to transparent.

Range.—This species has an extensive range, represented in the United States National Museum collection from the Red Sea to the Islands of Oceania (Marshall, Marianas, Phoenix, Samoan, Fiji) and the Ryukyu Islands.

Remarks.—Examination of the holotype of *A. nubilus* (M. C. Z. No. 28315) and of Garman's illustration leaves no question as to which species he studied, for the elongate mark below the eye is clearly visible, as is a blackish spot above the middle of the base of the caudal fin. Specimens ranging from the Red Sea to the Phoenix and Samoan Islands, when considered geographically, showed little variation in coloration, body form, and meristic characters. Those from the Red Sea average about one to two gill rakers more than specimens from other areas of the Indo-Pacific (table 5). Although

TABLE 5.—*Frequency distributions of the total number of gill rakers in four species of* Apogon

Species and locality	Total number of gill rakers on first gill arch							
	23	24	25	26	27	28	29	30
erdmani, new species, Red Sea			1	2	11	6	2	1
bandanensis Philippine Islands and East Indies		1	17	18	8	1		
savayensis								
Philippine Islands					8	1	1	
Northern Marshall Islands				5	4	5	2	
Samoa				1	3	8	4	4
Manga Reva					6	5	5	1
Totals for *savayensis*				6	21	19	12	5
nubilus								
Red Sea		2	1	12	6	4	1	
Philippine Islands and East Indies	1	4	5	6	1			
Okinawa		2	2	2				
Northern Marshall Islands	1	2	8	5	1		1	
Marianas Islands		1	7	10		1		
Phoenix		3	6	6	1			
Samoa		2	3		1			
Fiji			1					
Totals for *nubilus*, except from Red Sea	2	14	32	29	4	1	1	

Bleeker in his discussion (1854, p. 95) did not mention the characteristic mark below the cheek, he did include a rather narrow elongate mark in his figure, somewhat similar to that found in *nubilus*. It is possible, therefore, that Bleeker may have had specimens of *nubilus* as well as of *bandanensis*. The saddles passing through the spiny and soft dorsal fin certainly characterize his *bandanensis*. Günther (1871) points out that the cheek mark on his Samoan specimen (2½ inches in length) was "more distinct" than in specimens (3½ inches in length) from Manado, Celebes. Since the larger specimens had the smaller cheek mark, it is possible that Günther, too, had *nubilus*.

Several male specimens, 60 to 68 mm. in length, were found practicing oral incubation.

In summary, it is of interest to note that in the one division of this closely related group (*erdmani*, *bandanensis*, *savayensis*) differentiation has been complete to the species level in three areas, more

TABLE 6.—*Color and color patterns differentiating four species of* Apogon

Character	Species			
	erdmani	*bandanensis*	*savayensis*	*nubilus*
Cheek mark extending from eye to angle of anterior margin of preopercle.	Triangular, oblique direction.	Triangular, oblique direction	Triangular, slightly more horizontal.	Narrow, elongate, oblique direction.
Saddles over body, passing through bases of spiny and soft dorsal.	Always absent	Present	Always absent	Always absent.
Mark at base of caudal fin on caudal peduncle.	An intense brownish black band encircling caudal peduncle in young to adults.	A dark brown saddle over caudal peduncle in adults, extending to lateral line; tending to form a band almost encircling peduncle in young and juveniles, and faintly visible in adults.	A dark saddle over caudal peduncle in adults, reaching down to lateral line; a band almost encircling peduncle in young and some juveniles; the band of the young atrophies to a saddle in adults.	A diffuse dark spot on peduncle distinctly above midbase of caudal fin in adults, not forming a saddle; in young the tiny spot is at midbase of caudal fin, divided equally by lateral line, but migrates above lateral line with increase in size.
Color of caudal fin	Almost uniform dusky; in some a little heavier dusky on outer rays.	Outer rays blackish edged in white; remainder of fin dusky.	Outer rays blackish edged in white; remainder of fin dusky.	Uniformly dusky.
Faint dusky and silvery vertical bands on body.	Absent	Sometimes present	Sometimes present	Sometimes present.

or less, of the Indo-Pacific (the Red Sea, East Indies–Philippines, and Oceania). In the other division a single species exists throughout the Indo-Pacific with possible racial differentiation in the Red Sea.

STUDIES OF THE GENUS PARAMIA

Genus PARAMIA Bleeker

Paramia Bleeker, 1863, p. 233. (Genotype, *Cheilodipterus quinquelineatus* Cuvier and Valenciennes.)

Jadamga Schultz, 1940, p. 416. (Genotype, *Cheilodipterus quinquelineatus* Cuvier and Valenciennes.)

The genus *Paramia* is most closely related to *Cheilodipterus* Lacepède and *Cheilodipterops* Schultz. One or two symphyseal canines are present on each side of the tip of the lower jaw in the latter genus, these being absent in the former. The villiform teeth of the lower jaw in *Paramia* extend from the symphysis posteriorly, interrupted on each side by 2 to 6 enlarged canines. In this and other characters it is nearly identical with *Cheilodipterops*. In *Cheilodipterus* the band of villiform teeth in the lower jaw is wanting.

It is interesting to note the addition of a new species from the Persian Gulf to this genus, hitherto known as monotypic.

KEY TO THE SPECIES OF PARAMIA

1*a*. A black circular spot on dorsal side of caudal peduncle just before procurrent rays of caudal fin, with diameter about six times in least depth of caudal peduncle; five horizontal stripes on the body, counting the stripe on the midventral area located between pelvic bases, and the one on the middorsal side; snout shorter, length 2.8 to 3.0 in length of base of dorsal fin; least depth of caudal peduncle, in snout, extends well beyond tip; eye smaller, about 1.0 in snout, 3.2 to 3.5 in head length, 2.9 to 3.0 in length of base of dorsal fin; black spot at base of caudal fin oval and larger, greatest diameter less than 2.5 in least depth of caudal peduncle.
P. bipunctata, new species

1*b*. No spot on dorsal side of caudal peduncle; six horizontal body stripes, counting midventral and middorsal stripes; snout longer, length less than 2.5 in length of base of dorsal fin; caudal peduncle depth in snout usually touches tip or extends only slightly beyond snout; eye larger, about 0.9 in snout, 3.0 to 3.3 in head length, 2.2 to 2.8 in length of base of dorsal fin; black spot at base of caudal fin nearly circular and smaller, diameter more than 3.0 in least depth of caudal peduncle.
P. quinquelineata (Cuvier and Valenciennes)

PARAMIA BIPUNCTATA, new species

Plate 18, *d*

Holotype.—U.S.N.M. No. 147944, a specimen 47 mm. in standard length, collected by Donald S. Erdman, June 7, 1948, in Tarut Bay, Ras Tanura, Persian Gulf, Saudi Arabia.

Paratypes.—U.S.N.M. No. 112039, 2 specimens, 44 and 48 mm. in standard length, taken with the holotype and bearing same data.

Description.—This description is based on the holotype and two paratypes listed above. The counts and measurements are recorded for the holotype followed in parentheses by data from the paratypes, the smaller paratype listed first. Measurements are expressed in thousandths of the standard length. Where data are identical with that of the holotype but one number is given.

Dorsal rays VI–I,9; anal rays II,8; pectoral rays ii, 8, ii; lateral line scale rows 23; scale rows above lateral line 2; scale rows below lateral line 6.

Greatest body depth 298 (273, 292); body width 159 (170, 167); head length 371 (386, 396); head depth at occiput 238 (227, 229); length of caudal peduncle 255 (273, 272); least depth of caudal peduncle 117 (114, 125); length of longest pectoral ray 216 (227, 229); length of third spine of spiny dorsal 170 (182, 167); diameter of eye 106 (125, 125); length of upper jaw 170 (182, 181); length of snout 86 (91, 83); least width of bony interorbital 64 (68, 64); tip of snout to origin of spiny dorsal fin 404 (431, 416); tip of snout to origin of anal fin 638 (658, 666); tip of snout to insertion of pectoral fins 372 (375, 375); tip of snout to insertion of pelvic fins 383 (386, 396); tip of snout to anal opening 544 (523, 562); gill rakers 3,3+1+10,4 (4,3+1+11,2; 3,3+1+11,2).

First spine of spiny dorsal about three-fourths length of second spine; second spine about as long as third spine; first anal spine short, about one-seventh length of second; second anal spine about as long as first spine of spiny dorsal and equals diameter of eye; posterior margin of preopercle finely serrated, anterior margin smooth; scales ctenoid, with 6 to 10 radii; female specimen 48 mm. in standard length, with a short conical genital papilla; upper jaw reaches vertical drawn through middle of eye; lateral line complete; longest gill raker 1½ to 1¾ longer than longest filament, 2½ times in diameter of eye; peritoneum transparent with pepperlike spots; holotype with enlarged scale between the bases of the pelvic fins, lost in the paratypes.

Dentition pattern of the jaws similar to that as illustrated by Schultz (1940, p. 418, fig. 20, *c*). The lower jaw has from five to seven canine teeth on each side and the anterior portion of the jaw has a wide band of villiform teeth, typical of the genus. In the upper jaw, just posterior to a small patch of villiform teeth opposite each side of the symphysis, is found a group of from two to three canines. Vomer and palatines with small rounded to pointed villiform teeth.

Body elongate and somewhat slab sided; snout conical; caudal fin forked; contour of soft dorsal and anal fins apparently rounded; depressed spiny dorsal fin reaches anterior base of soft dorsal; pelvics reach vent but not origin of anal fin; all specimens immature.

Color in alcohol.—Body and head colored pale green with five horizontal blackish stripes; a middorsal stripe begins just behind interorbital area, passing posteriorly, dividing at origin of spiny dorsal, reuniting at end of soft dorsal and extending on caudal peduncle to spot on dorsal aspect of caudal peduncle and procurrent rays of caudal fin; a dorsolateral stripe extends from tip of snout, touching dorsal margin of eyes and anterior lateral line on body, dorsolaterally to area just before end of caudal peduncle; a median stripe begins at tip of snout and passes through middle of eye extending almost to spot at midbase of caudal fin; a ventrolateral stripe extends from tip of lower jaw through middle of upper jaw, touching lower margin of eye through base of pectoral and extending ventrolaterally to area just before end of peduncle; a midventral stripe extends from area anterior to midbelly, between bases of pelvics, dividing before vent and encircling anal fin, reuniting at end of anal and passing ventrally to end of caudal peduncle; a faint line is found on each side of isthmus extending from each side of tip of lower jaw to lower angle of preopercle; another faint line extends, on each side, obliquely forward on body from lateral base of pelvic to area just forward of pectoral base, and thence posteriorly to pectoral base; ventral stripe narrowest, only one-half as wide as other body stripes; width of median stripe at midbody about twice in diameter of pupil; a circular, black spot just before procurrent rays of caudal fin on dorsal aspect, its diameter about 6 times in least depth of caudal peduncle and about twice in pupil; a blackish oval spot at midbase of caudal fin, its greatest diameter on the horizontal axis about once in pupil, and encircled by a pigmentless area; some scattered melanophores on the upper parts of the membranes of the first two dorsal spines, remainder of fins transparent.

Color in life.—The following colors recorded in the field by Donald S. Erdman: Body silvery white with black stripes; black spot at midbase of caudal encircled by a yellow ring, its diameter equal to least depth of caudal peduncle.

Named *bipunctata*, in reference to the two spots on the caudal peduncle.

Ecology.—These specimens were taken by Donald S. Erdman at night near shore with a 100-foot drag net in shallow water over a sandy bottom.

PARAMIA QUINQUELINEATA (Cuvier and Valenciennes)

Cheilodipterus quinquelineatus Cuvier and Valenciennes, 1828, p. 167 (type locality, Borabora, Society Islands); Fowler and Bean, 1930, p. 127 (in part).

Specimens studied.—U.S.N.M. Nos. 150471 to 150519, 87 specimens, 1908–09, East Indies and Philippine Islands (*Albatross* expedition).

U.S.N.M. Nos. 150451, 17 specimens, April 1908, Catbalogan, Samar, Philippine Islands (*Albatross* expedition); U.S.N.M. Nos. 142450 to 142454, totaling 104 specimens, 1946 and 1947, northern Marshall Islands (Brock, Donaldson, Emmory, Herald, Kohler, Schultz) (also 28 specimens, not cataloged, from northern Marshall Islands collected by same party); U.S.N.M. Nos. 114977 to 114980, 40 specimens, May to July, 1939, Tutuila and Canton Island (Schultz); U.S.N.M. Nos. 52296 and 126286, totaling 10 specimens, 1902, Apia, Samoa (Jordan and Kellogg); U.S.N.M. No. 65976, 1 specimen, 1899–1900, Papeete Island, Society Islands (*Albatross* expedition).

Description.—The following counts and measurements were taken from 7 specimens, 32 to 76 mm.: Dorsal rays VI–I, 9; anal rays II, 8; pectoral rays ii, 8 or 9, ii; vertical scale rows 24 or 25; scale rows above lateral line 2; scale rows below lateral line 6 or 7.

Body depth 3.3 to 3.8; head length 2.4 to 2.5; length of caudal peduncle 3.7 to 4.0; length of longest pectoral ray 4.5 to 5.0 all in standard length; eye 3.0 to 3.3; length of upper jaw 2.0 to 2.1; least depth of caudal peduncle 3.0 to 3.2; snout 3.5 to 3.7; width of bony interorbital 6.3 to 7.2 all in length of head; eye in snout 0.9; second spine of spinous dorsal longest, about 3.1 to 3.4 in length of head in adults; gill rakers 4 or 5+1+12, the longest raker about equal to length of longest filament.

Caudal fin moderately forked; outline of rays of soft dorsal and anal fins slightly convex; free edge of preopercle serrated; scales ctenoid on body and head.

Color in alcohol.—Body and head light tan with six sharply defined brownish-black horizontal stripes extending from areas of the snout to the base of caudal fin; stripes located laterally on body about one-third width of lateral line scale taken from midbody area, and 5.5 to 7 in eye; width of area between stripes on lateral side of body 1½ to 2 times width of stripe; a dorsal stripe begins just posterior to interorbital area of midhead and extends dorsally to procurrent rays of caudal fin, dividing at origin of spinous dorsal and uniting at end of base of soft dorsal fin; a dorsolateral stripe extends from snout, dorsally, just touching dorsal margin of eye and anterior lateral line pores on body and passes posteriorly on dorsolateral portion of caudal peduncle; midbody stripe begins on tip of snout, passes through middle of eye and along midbody, extending almost to spot at base of caudal fin; a ventrolateral stripe extends from tip of lower jaw, along anterior portion of dentary, thence through upper jaw and just below eye, through base of pectoral fin and ventrolaterally to caudal base; another ventrolateral stripe passes from symphysis of lower jaw ventrally along inner edge of mandibular bones and lower edge of interopercle, passing just above base of pelvic fin and posteriorly near anal

base, uniting with stripe of opposite side at rear of anal base forming common ventral caudal peduncle stripe; a ventral stripe extends from the isthmus, just posterior of tip of lower jaw, touching inner branchiostegals of both sides, and on midbelly through bases of pelvics to vent; a conspicuous round, brownish-black spot at midbase of caudal fin, its diameter about five times in least depth of caudal peduncle; spot surrounded by a clear, nearly circular area, its diameter almost equal to the least depth of the caudal peduncle; stripes wider, more intense, and more sharply outlined on head; stripes taper very gradually from head to caudal peduncle, where they are less intense and have the least width; first two spines of spinous dorsal blackish, procurrent and outer two developed caudal rays with some black pigment, remainder of median and paired fins nearly transparent.

Range.—Represented in the United States National Museum collections from the East Indies, and the Philippine, Society, Phoenix, Samoan, and Marshall Islands.

LITERATURE CITED

BLEEKER, PIETER.

1852. Nieuwe bijdrage tot de kennis der ichthyologische fauna van het eiland Banka. Nat. Tijdschr. Nederl.-Indië, vol. 3, pp. 715–738.

1854. Derde bijdrage tot de kennis der ichthyologische fauna van de Banda-eilanden. Nat. Tijdschr. Nederl.-Indië, vol. 6, pp. 89–114.

1856a. Bijdrage tot de kennis der ichthyologische fauna van het eiland Boero. Nat. Tijdschr. Nederl.-Indië, vol. 11, pp. 383–414.

1856b. Beschrijvingven van nieuwe en weinig bekende vischsoorten van Amboina. Act. Soc. Sci. Indo-Neerl., vol. 1, pp. 1–76.

1863. Onzième notice sur la faune ichthyologique de l'Île de Ternate. Nederl. Tijdschr. Dierk., vol. 1, pp. 228–238.

1873–77. Atlas ichthyologique des Indes Orientales Néerlandaises, publié sous les auspices du Governement Colonial Néerlandais, Percoides, vol. 7, pp. 1–126, 1873–76; Percoides 1–42, tab. 279–320; vol. 8, pp. 1–156, 1876–77; Percoides, 43–78, tab. 321–354, 361–362.

1874. Révision des espèces indo-archipélagiques du groupe des Apogonini. Nat. Verh. Holl. Maatsch. Wetensch., 3. ser. 2, No. 1, pp. 1–82.

CANTOR, THEODORE EDWARD.

1850. Catalogue of Malayan fishes. Journ. Asiatic Soc. Bengal, vol. 18 (1949), pp. 983–1443, 14 pls.

CUVIER, G. L. C. F. D., and VALENCIENNES, ACHILLE.

1828–29. Histoire naturelle des poissons, vol. 2, 490 pp., 1828; vol. 3, 500 pp. 1829.

DAY, FRANCIS.

1867. On some new or imperfectly known fishes of Madras. Proc. Zool. Soc. London, 1867, pp. 935–942.

EVERMANN, BARTON WARREN, and SEALE, ALVIN.

1907. Fishes of the Philippine Islands. Bull. U. S. Bur. Fisheries, vol. 26 (1906), pp. 49–110, 22 figs.

FOWLER, HENRY W.

1918. New and little-known fishes from the Philippine Islands. Proc. Acad. Nat. Sci. Philadelphia, pp. 1–71, figs. 1–27.

FOWLER, HENRY W., and BEAN, BARTON A.

1930. The fishes of the families Amiidae, Chandidae, Duleidae, and Serranidae, obtained by the United States Bureau of Fisheries steamer *Albatross* in 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. U. S. Nat. Mus. Bull. 100, vol. 10, 334 pp., 24 figs.

GARMAN, SAMUEL.

1903. Some fishes from Australasia. Bull. Mus. Comp. Zool., vol. 39, pp. 229–241, 5 pls.

GILL, THEODORE NICHOLAS.

1864. Catalogue of the fishes of Lower California, in the Smithsonian Institution, collected by Mr. J. Xantus. Proc. Acad. Nat. Sci. Philadelphia, 1863, pp. 80–88.

GÜNTHER, ALBERT.

1859. Catalogue of the Acanthopterygian fishes in the collection of the British Museum, vol. 1, 524 pp.

1871. Report on several collections of fishes recently obtained for the British Museum. Proc. Zool. Soc. London, 1871, pp. 652–675, 18 pls.

1873. Andrew Garrett's Fische der Südsee, beschrieben und redigirt von A. C. L. G. Günther. Journ. Mus. Godeffroy, Heft 2, pp. 1–128, 83 pls.

HERRE, ALBERT W. C. T.

1935. A check list of the fishes of the Pelew Islands. Journ. Pan-Pacific Research Inst. vol. 10, no. 2, pp. 163–166.

1936. Fishes of the Crane Pacific Expedition. Publ. Field Mus. Nat. Hist., vol. 21, No. 353, 472 pp., figs. 1–50.

JORDAN, DAVID STARR, and SEALE, ALVIN.

1906. The fishes of Samoa. Description of the species found in the archipelago, with a provisional check-list of the fishes of Oceania. Bull. U. S. Bur. Fisheries, vol. 25, 1905, pp. 173–455, figs. 1–111, pls. 38–53.

JORDAN, DAVID STARR, and SNYDER, JOHN OTTERBEIN.

1901. A review of the cardinal fishes of Japan. Proc. U. S. Nat. Mus., vol. 23, pp. 891–913, 10 figs., 2 pls.

MACLEAY, WILLIAM.

1883–84. Contribution to the knowledge of the fishes of New Guinea. 4 parts. Proc. Linn. Soc. New South Wales, 1883, vol. 7, pp. 224–250, 252–280, 351–366, 585–598; 1884, vol. 8, pp. 252–280.

SCHULTZ, LEONARD PETER.

1940. Two new genera and three new species of cheilodipterid fishes, with notes on the other genera of the family. Proc. U. S. Nat. Mus., vol. 88, pp. 403–423, 2 figs.

1943. Fishes of the Phoenix and Samoan Islands collected in 1939 during the expedition of the U. S. S. *Bushnell*. U. S. Nat. Mus. Bull. 180, 316 pp., 27 figs.

SMITH, J. L. B.

1949. The sea fishes of South Africa. 550 pp., 1–103 pls., 1,245 figs.

STEINDACHNER, FRANZ, and DÖDERLEIN, LUDWIG.

1884. Beiträge zur Kenntniss der Fische Japan's. II. Denkschr. Akad. Wiss. Wien, vol. 48, pp. 1–40, 7 pls.

VALENCIENNES, ACHILLE.

1832. Description de plusieurs espèces nouvelles de poissons du genre *Apogon*. Nouv. Ann. Mus. Hist. Nat. Paris, vol. 1, pp. 51–60, pl. 4, figs. 1–4.

WEBER, MAX.

1913. Die Fische der *Siboga*-Expedition. 710 pp., 12 pls., 123 figs., Leyden.

WEBER, MAX, and DE BEAUFORT, L. F.

1929. The fishes of the Indo-Australian Archipelago, vol. 5, 458 pp., 98 illus.

U. S. GOVERNMENT PRINTING OFFICE: 1951